SUPREME COURT OF THE UNITED STATES.

OCTOBER TERM, 1924.

No. 296.

HARRY B. STILZ, APPELLANT,

vs.

THE UNITED STATES.

Appeal from the Court of Claims.

Appellant's Brief.

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STATEMENT OF THE CASE.

This suit was brought into the Court of Claims, under the act of July 1, 1918, 40 Stat. 705, for the alleged infringement of two patents by the United States Navy Department. The first patent, No. 945,873, was granted to Harry B. Stilz on January 11, 1910 for an improvement in oil burners. It has little value beyond being the progenitor of a later improvement for which letters patent No. 1,066,161 were granted to the same inventor on July 1, 1913.

Claim 2 of patent No. 945,873, which is relied upon in this suit, reads as follows:

> "A nozzle having a restricted discharge orifice, and independent inlets for a gaseous fluid and a liquid, there being a passage from each of said inlets to the discharge orifice, said passages having a portion in common which forms a mixing chamber, and each of said passages being arranged to produce a rotary motion in the fluid passing therethrough toward the discharge orifice."

It may be considered a genus claim, which is alleged to broadly cover the constructions of more recent origin, which have since proved to be most efficient in the art of burning fuels. The device which is described in said patent, however, has no bearing on the question at issue herein, since it belongs to a different species from the burners in suit.

The device which is illustrated and described in patent No. 1,066,161 is alleged to perform precisely the same function as is performed by the burners in suit. Claims 1, 6 and 7 of the latter patent, which are relied upon in this suit, are as follows:

> "1. A nozzle having a small discharge orifice, means immediately adjacent to said orifice for producing a whirling motion in a liquid fluid passing therethrough, a casing surrounding said nozzle and having a restricted discharge port concentric with said orifice and means for causing a gaseous fluid passing through the space within said casing to enter said port in a whirling current."
>
> "6. In combination, a furnace having an admission hole through its casing, a nozzle having means for projecting a hollow cone shaped film of oil from a round unobstructed delivery orifice into said furnace through said hole, means surrounding said nozzle for producing a whirling stream of gaseous fluid directed so as to penetrate said film of oil and means for supplying air into the furnace through said hole."
>
> "7. In combination, a furnace having an admission hole through its casing, a lining of refractory material for said hole, a nozzle having means for projecting a hollow cone shaped film of oil into said furnace through said hole, means surrounding said nozzle for producing a whirling stream of gaseous fluid directed so as to penetrate said film of oil, and means for supplying air into the furnace through said hole."

The discovery, which is disclosed in patent No. 1,066,161, was made during August of 1910 (page 2, par. V) and, in view of the

protection provided in claim 2 of patent No. 945,873, no haste was made to file an application for a patent on it.

Appellant was an employee in the Bureau of Construction and Repair of the Navy Department from 1900 to 1905. From 1905 until April 5, 1911, when he accepted a temporary appointment at the Mare Island Navy Yard, appellant was neither directly nor indirectly employed by the United States Government.

On May 8, 1911, during the time of his employment at the Mare Island Navy Yard, appellant filed, in the United States Patent Office, the application upon which Letters Patent No. 1,066,161 were issued on July 1, 1913.

In the prosecution of said application, the examiner refused to allow any of the claims, as originally filed, or as were offered in the various subsequent amendments. An appeal was carried to the Examiners-in-Chief, whose opinion thereon (Appeal No. 6022 in Exhibit B-1) was as follows:

> "We regard all of the appealed claims as allowable, there being in the prior art, as it is revealed by the examiner, no construction in which a whirling liquid cone of fuel is projected through a surrounding and whirling gaseous mass. It is old to discharge a whirling body of liquid fuel through an orifice surrounding another orifice for the emission of a gas, but in such construction the centrifugal action has no effect upon the liquid and the liquid will not cross the path of and commingle with the mass of the gas.
>
> "The decision of the examiner is reversed."

Appellant, having discovered a new principle in the art of burning fuels, was allowed to claim a monopoly on every combination in which the elements are defined by the word "means", so long as the combination operates on the new principle.

His claims were not restricted to the use of any particular kind of gaseous fluid, which is directed so as to penetrate the cone-shaped film of oil, or to any degree of pressure behind the fluids, which are brought togther by means of the burner structure. The novelty consists in the production of the whirling cone of fuel which, by centrifugal action, is projected through the air which is supplied for its combustion.

The invention of the patent in suit is basic in so far as a hollow cone-shaped spray of liquid is penetrated by a surrounding and whirling gaseous mass.

The problems involved in the burning of oil are stated in the appendix on page 36; the prior art in the burning of oil with mechanical atomization is outlined on page 38; and appellant's improvement in oil burners, where atomization is accomplished principally by mechanical means, is briefly set forth on page 41.

The Court of Claims, in the opinion which was handed down on December 17, 1923, relegated said claims of patent No. 1,066,161 to the margin without further comment than: "It seems to us impossible to read the claims of the plaintiff's patent alleged to be infringed upon the mechanical construction of the defendant's device."

The Court of Claims virtually swept aside these claims, avoided the decision which had been rendered by the Examiners-in-Chief of the United States Patent Office and, without having shown any cause why it should be done, virtually reversed said decision in substantially the following language:

> "Plaintiff's claims to invention may not under the law be accorded a wider scope than the bringing into existence of improvements to a device old in the art, well known to the public and in settled use—this identic device as improved"—which, because "the art is so narrow as to preclude the assertion of a claim for more than an identic device to accomplish a purpose long since accomplished and old in the art", a mere "expert mechanic" could have designed. "We are unable to perceive that the plaintiff has done more than set before the public a device which utilizes the agencies indispensable to be utilized, agencies well known and long employed, to attain improved atomization and fuel combustion and afford a practical burner" for which "the fundamental principles of differentiation (from the alleged infringing burners) are obvious and elementary."

ERRORS IN THE DECREE OF THE COURT OF CLAIMS.

(a) No knowledge or appreciation of the importance of the property of diffusion in all combustion processes was displayed and therefore the nature of the invention which is involved in this suit, was not comprehended.

(b) No heed was given to the established rule of law, that it is the claim of a patent that defines the invention that is patented and determines the rights of the patentee, the specification and drawing of the patent being merely illustrative and explanatory of what is in the claim.

(c) Appellant's patent rights were virtually limited to a copy right of the identic device as illustrated, shorn of all the descriptive matter contained within the specification relative to the novel function which said device performs.

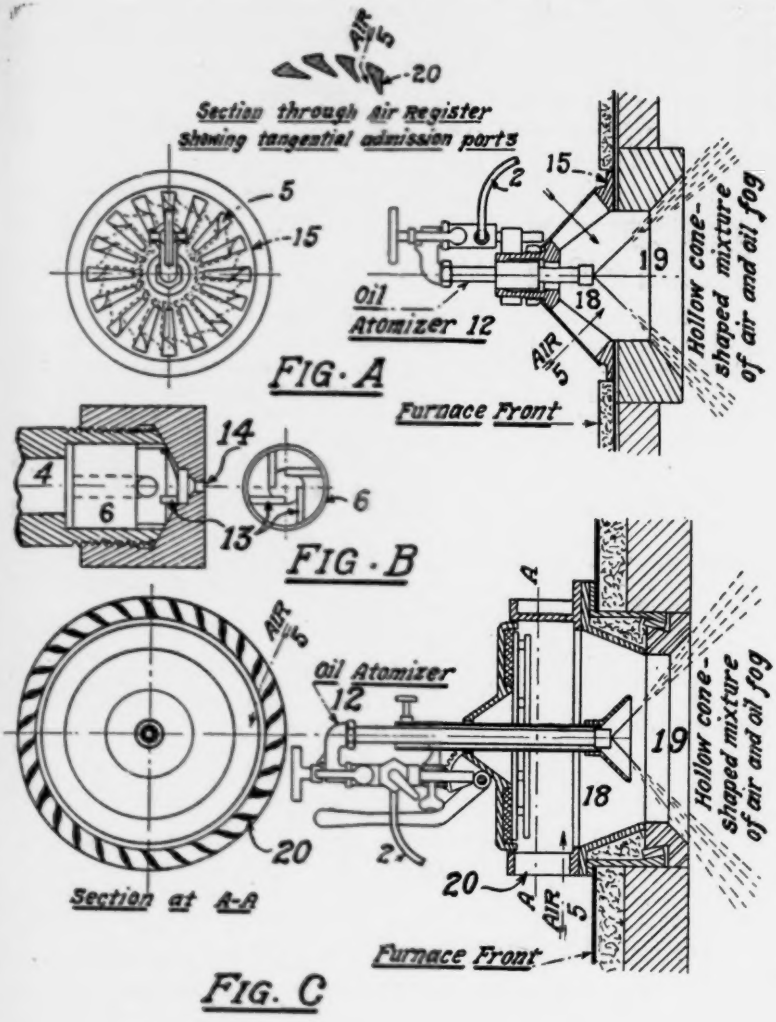
(d) It was held (Finding of Fact XII page 8) that the sworn statement of the plaintiff (Paragraph VIII, page 2), which was never denied by the defendant, does not constitute evidence.

(e) The contention that appellant had access to drawings, publications, etc., of oil burners, etc., at places where he was employed, was held to be material. (Finding of Fact No. I, page 3).

Invented things are not discovered in books; they are a product of some exercise of inventive faculties.

The primary question now at issue is whether the United States Patent Office was right, or whether the United States Court of Claims was right. If the Patent Office did not err in granting the claims in suit, the United States Navy Department must be guilty of infringement, since the oil burners in suit very clearly embody all of the elements which are set forth in said claims.

THE OIL BURNERS IN SUIT.



The United States Navy Department completed its first design of oil burners, which is alleged to embody said invention, on November 22, 1911. This design has since been designated the Bureau Standard Forced Draft Burner. Said first design is substantially as shown in Fig. A, which is a copy of Exhibit E-5. Exhibits E-1 and E-6 are likewise substantially the same as Fig. A.

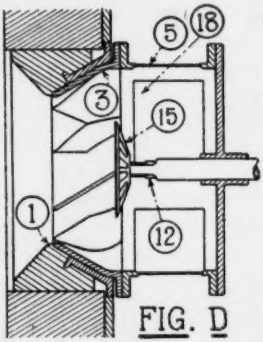


FIG. D

Fig. B shows the arrangement of passages for the oil within the discharge end of the Bureau Standard Atomizer, as shown in Exhibit E-2.

Fig. C represents a general arrangement of the Bureau Standard Natural Forced Draft Burner, copied from Exhibits E-3 and E-4

Fig. D represents the general arrangement of the burner (Exhibit E-7), which was manufactured by the Babcock & Wilcox Company, for use on the boilers of ships of the United States Navy.

Referring to Figs. B and C: Oil, under heavy pressure, is supplied to the atomizer 12, through the flexible tube 2, and passes through the central passage 4 leading to the nozzle which has a small discharge orifice 14. The plug 6, located within the nozzle, causes the oil to be divided into four streams, which flow at high velocity through the slots 13, to be discharged tangentially into a small chamber, which is immediately adjacent to the discharge orifice 14, thereby producing a whirling motion in the oil stream while passing therethrough.

Upon discharge, the oil spray takes the form of a cone-shaped film, composed of a myriad of streams, which rapidly break up into minute spheres, which ordinarily are projected forward in straight lines, the whirling motion in the oil film having ceased the instant the stream passes beyond the orifice 14.

The atomizer is located at the center of the burner casing to which it is secured. The casing is provided with vanes 20, which deflect the air tangentially and cause it to whirl around the atomizer as it is forced through the burner by means of centrifugal blowers, which discharge into an air-tight fire-room.

The conical surface within the burner casing, leading to the restricted discharge port 19, drives the whirling current of air in towards its axis of rotation ,thereby causing it to penetrate the oil film.

In Fig. A, precisely the same result is attained by means of the air register 15, which has a number of openings arranged around its conical surface and vanes are formed at said openings which deflect the air as it passes therethrough, so as to give it a whirling motion and likewise drive it in toward its axis of rotation.

In both burners, the oil film is converted into a whirling cone of fuel, which, by centrifugal action, is projected through and made to commingle with the air prior to its admission into the furnace.

In Fig. D, the air is admitted through four doors (5), which are arranged to guide it tangentially into the burner casing and cause it to whirl around the atomizer. A portion of this air passes through ports cut in the impeller plate (15), which is provided with a number of vanes, similar to those shown in the air register of Fig. A. The impeller plate (15) therefore gives to the air, which passes through the openings in it, an intensified whirl, while at the same time driving

it inward toward its axis of rotation. The major part of the air passes through the space between the periphery of the impeller plate (15) and the burner casing (3), it likewise being forced in a whirling current toward the axis by means of the conical surface leading to the restricted discharge port (1). The burner shown in Fig. D, therefore, combines in one structure both the methods for directing the air for combustion, as described in Figs. A and C.

The impeller plate (15) of Fig. D (likewise the air register 15, shown in Fig. A) functions precisely the same as, and is therefore the mechanical equivalent of, a casing having a restricted discharge port in combination with tangential inlets.

THE OIL BURNER ILLUSTRATED IN PATENT NO. 1,066,161.

Oil, under heavy pressure, is supplied to the atomizer 12, through the pipe 9, and flows at high velocity through the grooves of the spiral 15, to be discharged in a whirling current through the orifice 14. The resulting spray takes precisely the same form as that which is produced by the atomizer which is used in the burners in suit.

Surrounding the atomizer 12 is the casing 17, to which it is secured. Steam, under boiler pressure, is supplied from the pipe 10, through the nozzle 20, tangentially into the space 18. The whirling current of steam is driven in toward its axis of rotation by means of the conical surface leading to the restricted discharge port 19, where it penetrates the cone-shaped film of oil, which is discharged from the orifice 14 and converts it into a whirling cone of fuel. By centrifugal action, the oil is projected over the entire area of the admission port 8 to the furnace where it is forced to commingle with the air which is supplied for combustion, prior to entering the furnace.

This makes the front wall 3 of the furnace, containing the port 8, and the device 7, containing the ports 14 and 19, parts of the same structure, because they are all required to produce and confine a whirling cone of fuel in such a way that it may be projected uniformly through the air which is supplied for its combustion. And the patent claims in suit broadly cover all constructions, which effectually accomplish this result—a result which the United States Patent Office held had never been accomplished before, and no evidence to the contrary has since been discovered.

ALLEGED ANTICIPATION OF THE INVENTION DISCLOSED IN PATENT NO. 1,066,161.

The only reference, outside of those which had been cited by the Patent Office, which was alleged to be a complete anticipation of patent No. 1,066,161, is the Armstrong patent (Exhibit C-12). But the drawings in the Armstrong patent do not show any such structure as is claimed in patent No. 1,066,161. Certain vague statements, which are found in the Armstrong specifications, are relied upon to prove anticipation.

Now words are worthless things, unless they convey an idea or produce a result. An expert witness, appearing in this suit, was evidently the first person to discover that Armstrong knew and had shown others how to construct the type of oil burner, which is involved in this action. But for some reason Armstrong himself and all the others, prior to 1911, continued to make, use and vend burners, which are decidedly inferior to that type which he is now alleged to have included within the scope of the general language of his specification.

It remained for the wisdom that comes after the fact to teach that the thing, which had eluded the search of the world until Aug. 1, 1910, had been fully disclosed during 1904, through a combination of words, and that, if the proper meaning had been attached to each of these words and it had been known just how, when and where to bring into action, in a single structure, the elements thus described, the coveted result would have been produced—a problem which, having been solved, no longer presents any difficulty.

OBJECTS IN VIEW WHEN THE APPLICATION FOR PATENT NO. 1,066,161 WAS FILED.

The relevant objects in view were to "produce a burner which will produce perfect combustion by insuring a perfect admixture of air with the fuel right at the zone of combustion; to utilize the velocity of the atomizing steam in such a manner that it will be dissipated in diffusing the oil into a spray, which then enters the furnace at a relatively low velocity". .(page 1, lines 90 to 97 of patent No. 1,066,161) "thus affording the best opportunity for a perfect mixing of the jet with the air" (page 2, lines 127 to 129 of said patent).

It is also stated: "The oil leaves the inner orifice of the nozzle in a conical spray and, before it can pass through the outer orifice, it is caught by the rotating steam and is perfectly atomized. In this condition, the oil mixes with the requisite amount of air just as it reaches the hot refractory wall and perfect combustion ensues," (page 3, lines 1 to 8 of patent No. 1,066,161). "It will be understood that other gases than steam may be used for atomizing purposes." (Page 3, lines 18 to 20 of said patent).

"The nozzle may take various forms, so long as it produces a whirling spray of atomized oil under all conditions which are encountered in practice." (Page 2, lines 80 to 83 of said patent).

And no construction has since been devised which more effectually produces a whirling cone of nebulized fuel, or which yields a higher efficiency of combustion, than that construction which is illustrated in patent No. 1,066,161.

The object which the applicant for said patent had in view is still further disclosed in claim 11, forming part of his original application (paper No. 2 of Exhibit B-1). It reads:

> "In combination, a furnace having an admission hole through its casing, a nozzle having means for projecting oil into said furnace through said hole, and means within said nozzle for producing a whirling stream of gaseous fluid directed so as to swing said oil over an area filling said hole,

and means for admitting air into the furnace through said hole."

This claim was subsequently amended to the form in which it now appears as claim 6, in order to state with more particularity the elements required for high efficiency in the operation of this type of burner. In the "nozzle having means for projecting oil into said furnace" there must needs be included the means for likewise converting the oil into the form of a hollow cone-shaped film, in order that the spray may be distributed uniformly over the area of the admission hole into the furnace. Moreover, in order that the "whirling stream of gaseous fluid" may effectually "swing" the oil over the area of the admission hole, it is essential that it be "directed so as to penetrate said film of oil." Without such a penetration, the oil would not be converted into a whirling cone of fuel and it would therefore not "swing."

All of these elements were, of course, shown in the original drawings of said patent and they form part of all burners at present known, by means of which instantaneous diffusion and uniform admixture of air and fuel can be produced.

In line with the above, it is stated in the specification:

". . . it is possible to regulate the divergence of the spray so as to cause it completely to fill the opening (8) . . ." (page 2 lines 39 to 41)

"Consequently, the fuel and the incoming air are brought together in a zone where combustion immediately begins, so that perfect combustion of the oil results and the furnace becomes filled with a slowly moving flame which spreads out on all sides as soon as the refractory wall is passed." (page 2, lines 54 to 60).

HOW THE IMPROVEMENT DISCLOSED IN PATENT NO. 1,066,161 HAS BEEN EMBODIED IN THE BURNERS IN SUIT.

It requires a very considerable amount of energy in order to drive a whirling stream of gaseous fluid in toward the axis of rotation. The steam required to operate the blowers, which force the air through the burners in suit forms a very material part of the total steam generated by the heat, which the burners produce—in fact, several times the amount of steam which is required to operate the burner shown in patent No. 1,066,161 with equal combustion efficiency.

The air pressure carried within the closed fire rooms of the United States Navy ships, varies from 2 to 8 inches of water; and this theoretically gives to the air, escaping from under such pressures, velocities of from 92 to 184 feet per second (roughly from one to two miles a minute—and everyone knows that a mile-a-minute wind is by no means mild).

The rate of the gyrations of a whirling current of air, moving at such velocities, becomes very high, as the air currents approach the axis of gyration. These whirling air currents, therefore, exert a very considerable centrifugal force and a large component thereof operates directly against the pressure, which is produced by the air blowers.

In the prior art, where the whirling air currents were not driven in toward the axis, there is no component of the centrifugal

force, which is produced, to act against the blower pressure; the centrifugal action in such construction is fully met by the reaction from the casing for containing the air currents.

There is therefore more energy in a whirling current, which is driven in toward the axis of rotation, than in a whirling current, the particles of which, while traveling at the same velocity, are not forced to change their respective positions relative to the axis. Moreover, this energy, in the former case, is concentrated near the axis of gyration, producing a violent action at the very place where the cone-shaped film of oil is projected into it. There is as much difference in the effect produced within the burners of the prior art, which were mere modifications of Schutte's patent No. 391,865, and the burners in suit, where the whirling air is driven in toward the axis of gyration, as there is between the effect produced by an ordinary wind storm and a tornado.

This additional energy would not be applied to air blowers in practice, unless there was thereby produced some highly desired result, which is absent when the air from the blowers is not driven in toward the axis of gyration by the restricted discharge port of the burner structure, or its equivalent.

In view of the well known destructive power of a tornado, there should be no question but that the air currents in the burners in suit do assist in the atomization of the oil, a relatively small amount, of course, when the oil pressure is from 200 to 300 pounds per sq. in. and the air pressure is only 2 to 8 inches of water pressure, as compared with the assistance which is rendered when the oil is under a lower pressure and the gaseous fluid is discharged from under a pressure of a hundred pounds per sq. in., or so.

While perfect atomization is necessary in order to secure rapid diffusion, it is only one of several means used in the attainment of this desired end.

It is immaterial by what process the "perfect atomization" may be secured, so long as the nozzle has **means for projecting a hollow cone-shaped film of oil into said furnace through said hole** (claim 7); i. e. so long as the atomized spray is spread out as over the surface of a cone, so that it may be effectually converted into a whirling cone of fuel and uniformly mixed with the air which must likewise pass "through said hole."

There is quite a variety of structures on the market by means of which oil can be atomized perfectly, so far as satisfying all the practical needs for combustion. One must therefore look beyond the question of atomization in order to show cause why burners, embodying the combination of elements set forth in the patent claims in suit, are superior to other burners. It appears evident enough, upon reflection, that the crux of the issue depends on the property of diffusion, as it was so clearly and concisely stated in the decision, adverted to on page 19, which was handed down by the Examiner-in-Chief of the United States Patent Office, on April 28, 1913.

THE PATENT CLAIMS IN SUIT APPLIED TO THE BURNERS IN SUIT.

Claim 2 of patent No. 945,873.

1. **A nozzle:** The entire burner structure shown in Figs. A, C and D.

2. **Having a restricted discharge orifice:** (19) in Figs. A and C, and (1) in Fig. D.

3. **and independent inlets for a gaseous fluid:** (5) in Figs. A. C and D.

4. **and a liquid:** the tube (2) communicating with the atomizer (12) in Figs. A and C and a similar supply tube (not shown) to the atomizer (12), the outer end of which is broken off in Fig. D.

5. **there being a passage from each of said inlets to the discharge orifice:** (18) for the air in Figs. A, C and D and (4) shown in Fig. B for the oil through the atomizer (12).

6. **said passages having a portion in common which forms a mixing chamber:** the space within the burner casing (nozzle) immediately adjacent to the restricted discharge orifice (19) in Figs. A and C and (1) in Fig. D.

7. **and each of said passages being arranged to produce a rotary motion in the fluid passing therethrough toward the discharge orifice:** In the air passage, this is accomplished by the inclined vanes (20) in Figs. A and C, and by the inclined doors (5), assisted by the inclined vanes formed at the ports through (15), in Fig. D. In the oil passage, it is accomplished by the tangential slots (13) on the end of plug (6), shown in Fig. B.

The device illustrated in patent No. 945,873 may produce a miniature tornado, the same as the device illustrated in patent No. 1,066,161, but the mixing chamber in the former device is not located to best advantage. The oil was not introduced into the whirling gaseous fluid at such a position and in such a condition as to produce the results which, it has been discovered, are attainable with the arrangement shown in the latter device.

Claim 1 of patent No. 1,066,161.

1. **A nozzle:** The mechanical atomizer (12).

2. **having a small discharge orifice:** (14).

3. **means immediately adjacent to said orifice for producing a whirling motion in a liquid fluid passing therethrough:** the tangential slots (13) in Fig. B.

4. **a casing surrounding said nozzle:** The burner structure for containing the air which passes therethrough.

5. **and having a restricted discharge port concentric with said orifice:** The circular opening marked (19) in Figs. A and C and (1) in Fig. D.

6. **and means for causing a gaseous fluid passing through the space within said casing to enter said port in a whirling current:** The "gaseous fluid" here is the air which is supplied for the combustion of the oil. It is forced through the burners by means of blowers and caused to enter the port (19) in a whirling current by means of the tangential inlets (5) in Figs. A and C. In Fig. D the air is made to

whirl through the port (1) by means of the inclined doors (5), assisted by the impeller (15).

Claim 6 of patent No. 1,066,161.

1. **A furnace having an admission hole through its casing:** A portion of the front wall, or casing, of the furnace is shown in section, the admission hole being marked (19) in Figs. A and C and (1) in Fig. D.

2. **a nozzle having means for projecting a hollow cone-shaped film of oil from a round unobstructed delivery orifice into said furnace through said hole:** The nozzle (12) in Figs. A, C and D is provided with means for whirling the oil, from under a high pressure, through a small orifice, as shown in Fig. B, which causes it to take the form of a cone-shaped film upon delivery.

3. **means surrounding said nozzle for producing a whirling stream of gaseous fluid directed so as to penetrate said film of oil:** In Fig. A, air from the closed fire room, under a pressure of from 2 to 8 inches of water, flows through 16 ports (5) of the register (15). Vanes are formed at said ports, which direct the air so as to cause it to whirl around the atomizer (12) while likewise driving it through the film of oil inward toward the axis of gyration. In Fig. C, the air flows through 30 ports (5) tangentially into the space within the burner casing where it whirls around the atomizer (12). The conical surface within said casing leading to the discharge port (19) drives the air through the oil film inward toward the axis of gyration. In Fig. D, that part of the air flowing through the burner casing, which passes through the impeller (15), receives an intensified whirl, while likewise being driven through the oil film toward the axis of gyration.

This element causes a penetration of the oil film in all three burners shown, and produces a whirling cone of fuel.

4. **and means for supplying air into the furnace through said hole:** This element includes the means for creating a difference in pressure between the fire room and the furnace, the ports (5) and the passages within the burner casings shown in Figs. A, C and D, providing the means for controlling the air currents into the furnace.

The above analysis applies to claim 7 as well, there being added here merely the lining of refractory material for the hole through the furnace casing, the same being clearly indicated in Figs. A, C and D.

ADJUDICATION OF PATENT NO. 1,066,161 IN THE UNITED STATES DISTRICT COURT FOR THE SOUTHERN DISTRICT OF NEW YORK.

In order to avoid any possible interference of the nature stated in Finding of Fact No. XIII, appellant amended his bill of complaint in the United States District Court for the Southern District of New York, by striking out all reference therein contained to the sale of oil burners by the Babcock & Wilcox Company to the United States.

This case was tried before Honorable Augustus N. Hand on Oct. 24 and 25, 1923, who filed his opinion on Feb. 27, 1924, dismissing the bill because the defendant did not infringe the patent. The B & W oil burner is shown as Fig. D herein.

Judge Hand held that the patent to Laing (Exhibits D-6 and D-8) necessitates an interpretation of the claims of patent No. 1,066,161, which must differ decidedly from the language in which they are clearly and concisely stated.

The Examiners-in-Chief of the United States Patent Office had this matter fully before them when they allowed said claims (Exhibit B-1, paper No. 23, last paragraph on page 4).

Certainly, Laing did not claim any such invention as is claimed in patent No. 1,066,161. If he had disclosed anything whatever in anticipation thereof, the fact remains that his disclosure was not published in the United States until Sept. 17, 1910, while the invention involved in this suit was reduced to practice during August of 1910. This circumstance was evidently overlooked by the Court.

The Babcock & Wilcox case was prosecuted *in forma pauperis* and the plaintiff had no New York representative. He had not been notified that an opinion had been filed, when he received a copy of the decree from the attorneys for the defendant, on Mar. 7, 1924, with notice that the same would be presented for settlement on March 14, and it was not until Mar. 20 that he succeeded in getting a copy of the Court's opinion.

The final decree having been signed on Mar. 14, he was unable to move for a rehearing, and he believed that his only remedy thereafter was to appeal to the United States Circuit Court of Appeals for the Second Circuit. An appeal was taken and is now pending.

It may be well to mention, in passing, that claim 2 of patent No. 945,873 in suit fully covers the structure disclosed by Laing, and the filing date by Laing was subsequent to that of the application for patent No. 945,873. It is maintained, however, that the invention of the Laing patent belongs to a different species from the invention of patent No. 1,066,161, since Laing introduces a non-whirling stratum of air where it acts as a buffer to prevent the outer whirling current of air from converting the inner film of oil into a whirling cone of fuel.

The United States District Court for the Eastern District of Pennsylvania has taken no action of any sort toward bringing to trial the other case referred to in Finding of Fact No. XIII.

FURTHER CAUSE WHY THE PETITION IN THE COURT BELOW SHOULD NOT BE DISMISSED.

The oil burner illustrated in patent No. 1,066,161 is of very simple construction. Any machinist can make one for a few dollar's worth of time and material—after having been shown how. The Big Interests showed no intention of buying from another, or of paying license fees for the right to use a device which they could make for themselves at negligable cost. They evidently decided that it would be cheaper, and therefore more desirable, to destroy any monopoly which might show signs of growing out of the patent rights.

No honorable offer to purchase these patent rights from the owner thereof was permitted for the reason that he was known to be the inventor also of a novel internal combustion engine, by means of which power could be generated at a small fraction of what it now costs when generated from the gasoline engine.

Articles appearing in the April 22, 1909 issue of "Engineering News" and other publications relative to the results obtained with two experimental engines which he had constructed and a full disclosure of the theory involved, had shown the practicability of this invention.

As a consequence, appellant has been unable to sell enough oil burners during the past 14 years to pay for his daily bread, notwithstanding the enormous demand for burners which has existed and the fact that his burner has shown decided superiority over all others, in every single competitive test which has been made on it. Moreover, he has been unable to find anyone, during this period, who has dared to assist him toward asserting his lawful rights, under the terms of the contracts accompanying said patents, and it is only at rare intervals that he has been permitted to earn money through any line of endeavor.

The consensus of opinion, therefore, which appears to have existed for a considerable time, is not in agreement with the opinion which was handed down by the Court of Claims.

Had it been thought possible to construct a device which produced the same result as is produced by that which is illustrated in patent No. 1,066,161, without infringing upon the claims thereof, no one would have taken the pains and incurred the expense necessary to prevent publicity being given to the use of such devices.

Had the device, illustrated in patent No. 1,066,161, been no better than other devices, which could be constructed without infringing the claims thereof, there would have been no occasion to bring into action such astounding methods as have been employed to prevent appellant asserting his lawful rights.

It is a costly process to excommunicate an individual from all persons, who might be persuaded to lend their support toward placing a valuable invention on the market; to institute a propaganda, which deprives one of his past friendships and prevents the formation of new ones; to maintain a system of espionage, which keeps track of all his personal movements, as well as his mail; to provide "doubles" to impersonate men of influence (including Government Officials), when he endeavors to interview them through the regulation methods of procedure; to have him arrested and imprisoned at critical times, either for the purpose of preventing him meeting men of influence on the public highway, or for the purpose of intimidating him when he sought legal action in the courts; to cause atrocities to be committed, which throw financial districts into consternation at times when there seems to be a likelihood of aid being rendered toward giving publicity to his invention, thereby intimidating others; to cause false reports to be circulated by those (including Government Officials) who have been assigned to conduct tests on devices embodying his invention; to cause parties, who did have the hardihood to aid him in his efforts to earn a livelihood to become involved in financial difficulties, labor troubles or other sources of worry, so that they would or could not render further aid; and to otherwise crush his productive powers and injure him in his efforts to establish the monopoly to which he is lawfully entitled under the terms of the contract, which was issued by the United States Patent Office.

These are facts which were not brought out in the evidence in this suit, other than in the general language of his affidavit of poverty. It is believed that they should be introduced in the evidence of this case. The acts of July 20, 1892, c. 209, 27 Stat. 252 and June 25, 1910, c. 435, 36 Stat. 866 provide the means to that end, including: "witnesses shall attend as in other cases, and the plaintiff shall have the same remedies as are provided by law in other cases."

Appellant believes that he is entitled to recover damages which he has sustained because of a broken contract, if not in accordance with the Revised Statutes, Title LX, Sec. 4919. Moreover , it seems fitting and proper that the Sovereign Citizens of the United States should be shown how certain of their public officials entice an army of men to exercise their inventive faculties and sign a contract with those who, in addition to the labor involved in producing that which is alleged to be new and useful, are willing to pay into the Treasury of the United States certain stipulated fees; while other public officials not only break the contract, when it is to their advantage to do so, but deliberately support a conspiracy to "freeze-out" the owner thereof, if he cannot be persuaded to surrender the same, should it later be discovered to be a thing having real value.

It was not until after appellant had been incarcerated for nearly three years in insane asylums, by processes which boldly violated Articles V and VI of the Amendments to the United States Constitution;after it had been demonstrated that he was effectually barred from securing his day in court, where he could learn who it was that inspired the crime of having him committed where he had to listen to unearthly noises and witness nauseating sights; after it had appeared certain that he must go through the remainder of his life branded "insane", with people having full right to say at any time that he was merely "out on a visit"; It was not until it had been clearly seen that he was a Citizen of the United States, whose rights under the common law were extremely limited, that the various parties, who are now making, using and vending oil burners, which infringe his patents, permitted descriptions of such burners to appear in the public press.

It was not until all of this had occurred that he was able to secure direct evidence of the nature of the improvement, which the United States Navy Department made during 1911 in the oil burners, which have since been installed on the boilers of all its ships.

It was not until the United States Government had clearly shown in what manner it now honors a successful inventor and how effective are the means employed to prevent people from enjoying the benefits which may follow from the legitimate use of his invention—it was not until then that the fear of an enforcement of said contracts had subsided, and, whereas people infringed secretly before, they now do so openly.

It could not possibly have been otherwise, after it had been demonstrated that the Government now holds less respect for an inventor, who has already developed an epoch-making improvement in the art of burning fuels and who stands ready to supply the crying need of the hour—cheap mechanical power—than it accords to its lowest type of criminals, who at least are permitted to face their

accusers, before being condemned to imprisonment; that the United States has become a place where an ignorant immigrant can earn a decent living, but a successful inventor, owning a valuable patent contract, has been obliged to lead the life of a pauper, since the day when the value of his invention became known, a victim of that peculiar paradox in human nature, that people hate most bitterly those whom they have injured and from which there appears to be no relief, unless the Government changes its long continued attitude of complacent indifference to his numerous appeals for the protection to which he is entitled under the law.

Appellant has been helpless for so long a time in asserting his lawful rights, that people were eventually justified in believing that he had none.

Much of this could have been prevented had appellant been provided with the means, to which he was legally entitled, for taking testimony in this case.

Appellant has at hand the best of evidence to prove that the most cunning, as well as the most atrocious schemes ever conceived have been brought into action, in order to prevent any individual from co-operating with him in his efforts to supply an effective means for conserving nature's recources, and that the Government itself has been decidedly antagonistic toward any such efforts, reserving its greatest rewards and honors for those who succeed in devising ways and means for destroying two tons of nature's resources, where only one ton was destroyed before, thereby multiplying the profits which flow unto those who usually provide the funds for campaign purposes at election times.

There is evidence available to prove that the costs of maintaining this conspiracy have been enormous; but great as have been these costs, they sink into insignificance in amount as compared with that of the losses, which the people have suffered because of it. And great as have been these financial losses, they are small when compared with the losses of honor, virility and character among people. who have been induced to support such a conspiracy.

Weak and poor indeed is any nation, that can see no injustice in such methods as employed here, to break a solemn contract, which a government entered into with one of its citizens. In any nation where there may have developed such a sense of justice, all other strengths and enormities of bullion and arsenals and warehouses can be no strength whatever, but may be quite the reverse.

It is respectfully submitted that the decree below should be reversed and the case remanded, with authority to amend the petition so as to include in the claim all compensation to which appellant is justly entitled, his power to take testimony in the original action, having been extremely limited, through no fault of his own.

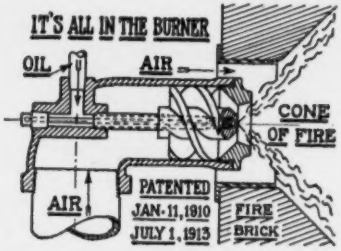
Harry B. Stilz

APPELLANT.

IT STANDS ALONE—IN A CLASS BY ITSELF

THE UNIVERSAL BURNER

The most effective means known for conserving fuel.



The instantaneous diffusion of finely-divided fuel and air here produces virtually a

A FLAMELESS FIRE.

The maximum temperature of combustion attainable with

A NON-OXIDIZING FIRE.

A soft fire of great intensity, restricted to a small space immediately adjacent to the burner, is made with

GAS, POWDERED COAL, OIL.

Nebulized fuel, projected into a miniature tornado, created by chimney draft, blower air, compressed air, or steam effects

A PHENOMENAL HEATING EFFICIENCY.

Invented and Manufactured by

H. B. STILZ

1949 N. THIRTEENTH STREET, PHILADELPHIA, PA.

LINK-BELT COMPANY

Nicetown, Philadelphia, Pa., April 1, 1912.

H. B. Stilz,
Philadelphia, Pa.

Dear Sir:—

In a recent competitive test, which we conducted in our shop, we found that the burners which we are using took 2½ times as long and 3¼ times as much oil as the Stilz burner to heat our furnaces to 2000 degrees Fahr.

We will immediately equip some of our furnaces with your burners, and if results prove as satisfactory as the test leads us to believe that they will, we will ultimately install them throughout our plant.

Yours very truly,

Link Belt Company,

(signed) *C. W. Adams,* Superintendent.

In every test, without exception, which has been conducted in every section of the United States, it was found that this burner was decidedly more efficient than the burner with which it competed.

In the cement industry, when installed on rotary kilns, this burner produced the same amount of cement clinker with 25% less oil than was required with the next best oil burner then in use. It increased the capacity of the kiln 50% and abolished ring formations within the same.

S. L. ALLEN & CO., INC.

5th St. and Glenwood Avenue

Philadelphia, March 5th, 1923.

Mr. H. B. Stilz,
Philadelphia, Pa.

Dear Sir:—

Replying to your inquiry as to performance of your No. 12½-B Oil Burner, we are pleased to state that of the many burners tried in our plant, yours displays very definitely the cleanest combustion and most uniform heating qualities.

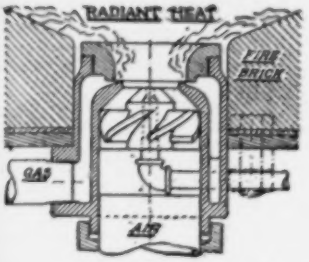
We have been very favorably impressed also with the non-oxidizing characteristics of this burner. We have accomplished a large quantity of work with your burner in a single oven furnace which all others, so far as we know, could not accomplish, except with a semi-muffle furnace, and the goods leave the furnace practically free from scale.

We are considering the application of a number of these burners to other furnaces in the near future.

Very truly yours,

S. L. Allen & Co., Inc.

(signed) *R. P. Thatcher.*



Sixty-three cents worth of Gas will do the work of a dollar's worth

With this burner, a perfect mixture of air and gas is produced wholly within the combustion chamber.

A back-fire is impossible.

UNITED GAS IMPROVEMENT COMPANY

Philadelphia, Pa., Feb. 11, 1921.

Mr. S. T. Bodine,
President.

Dear Mr. Bodine:—

Mr. H. B. Stilz has submitted to the Appliance Laboratory of the United Gas Improvement Company for test, a gas burner intended for industrial application. The Appliance Laboratory has conducted a series of tests on this Stilz Burner, using for the purpose an existing form of candy furnace. This furnace, with the burner provided for it by its maker, gave an efficiency, starting all cold, of 36.1 per cent and starting all hot, of 42 per cent. The operation was practically silent. The air pressure required for the several adjustments used, varied from 1.4 to 3.4 inches of water.

In order to secure the highest efficiency with the Stilz Burner, it is essential to provide a specially shaped fire-brick ring, upon the surface of which the fire is made to play, heating it to incandescence, so that a large part of the heat can be transmitted to the kettle by radiation, instead of by convection, as occurs with the other burner tested. We made the changes to the furnace that Mr. Stilz and we considered would so improve it for use with the Stilz Burner. These changes having been made, a test showed that the Stilz Burner gave an efficiency, under these conditions, of 57.3 per cent. when the test was started with the furnace cold, and of 61 per cent. when the test was started with the furnace hot. The air pressure was 1.7 inches of water.

These tests were made upon a 20-inch diameter copper candy pan, placed in the top of a furnace built for the purpose. The determination of efficiency was made with a water evaporation test. The operation of the furnace with the Stilz Burner was noisy.

The efficiencies are the relation of the heat conveyed to the water to the heat that the perfect combustion of the gas would develop.

We have not so far tested the Stilz Burner in connection with furnaces for purposes other than the boiling of water in a candy furnace.

With regards—

Respectfully,
(signed) *Walton Clark*, Vice-Pres.

AN OUTLINE OF FUNDAMENTALS

A burner is a piece of mechanism, by means of which a fuel is intermixed with air and combustion thereby promoted.

The term combustion is commonly accepted as referring to the process of burning, whereby a substance unites with oxygen, with the resulting production of light and heat.

Fuels may be defined as those substances which, by means of atmospheric air, can be economically burned to generate heat.

The two elements contributing most largely to the economic value of any fuel, as measured by its heating power, are carbon and hydrogen which, when burned in a sufficient supply of oxygen, are converted into carbon dioxide and water in a gaseous condition.

Although oxygen, the universal supporter of combustion, as here defined, is the most abundant of all natural substances, it never exists by itself in nature, but always in association with other substances. Thus it is that, as a constituent of atmospheric air, it is associated with the the inert gas, nitrogen; the relative proportions of the two gases in pure air remaining practically constant under all conditions, viz. 21.3% oxygen is mixed with 78.7% of nitrogen by volume.

The ultimate efficiency of a fuel should be expressed in the total amount of heat it is capable of generating. The proportion of that heat which is utilized, depends in greatest measure upon the method which is used to burn it.

The amount of air which is required to burn a given fuel is easily calculated. If less than this amount is supplied, a certain portion of the carbon passes off unconsumed and forms smoke; while a part of the remainder, being insufficiently supplied with oxygen, forms carbon monoxide, the product of incomplete combustion. If the air is supplied in excess of that necessary for perfect combustion, there is a definite loss, which is two-fold in character: First, the excess of air entering the furnace is heated by the burning fuel, thereby lowering the temperature of the mixture of gases and air below that which would prevail if the gases only were present. This reduces the rate at which heat can be transmitted to that which is being heated and tends furthermore to prevent the combustion from maintaining a kindling temperature. Second, owing to the larger volume and higher velocity, a smaller portion of the gases comes in actual contact with the heating surfaces and the time of contact therewith is shorter, so that the temperature of the mixture of the gases and air escaping to the atmosphere is higher than would be the case if there were no excess of air; while the increased volume is such that the total amount of heat thus carried away, without exerting any useful effect, is greatly increased. By way of illustration, when hydrogen and oxygen, with neither in excess, are burned, a temperature of 3,191 degrees centigrade is produced. If hydrogen is burned in air, only 2,010 degrees can be obtained, while, with 25 per cent excess of air, a temperature of but 1,700 degrees results.

To secure perfect combustion with the minimum amount of air require a uniform distribution of finely-divided fuel throughout the air.

The only natural liquid-fuel is crude petroleum, which is composed of a great number of liquid hydro-carbons of widely varying specific gravity and chemical composition.

A fuel cannot be burned in the liquid state. It must first be vaporized through the application of heat and then the vapor must be raised to the ignition temperature before its union with oxygen can be effected.

In order to secure the highest efficiency in the burning of oil it is essential: First, the oil must be converted into a vapor; second, the precise amount of air must be supplied to cause the complete oxidation of the constituent elements of the oil, and third, diffusion should be instantaneous.

When crude petroleum is heated to a degree sufficient to vaporize the heavier components thereof, there results a dissociation of some of its hydro-carbon compounds and carbon is deposited within the chamber in which the heating is effected. In order to completely burn this variety of oil in practice, therefore, it must be atomized and projected into the furnace where, because of its widely-exposed surface, it is instantly vaporized by the heat therein.

The work necessarily performed by the atomizing agent is simply the work of stretching the surface, by converting the oil, which, in bulk, has practically no surface, into a myriad of minute spheres.

There are two widely-used methods of atomizing liquids. In the first, a current of gaseous fluid is blown upon a stream of liquid in such manner as to rapidly break it up into small drops, which are carried along in the current. Devices in which this operation is performed, are known as steam or air atomizers. In the second, the liquid is given a whirling motion as it is projected through a small orifice, the resulting spray taking the form of a widely-diverging cone of extremely fine mist. Devices in which this operation is performed, are known as mechanical atomizers.

To supply the air which is required for combustion, is an equally simple operation. Three methods are in wide use: First, the air is drawn into the furnace by chimney draft; second, the air is blown into the furnace by mechanical means, and third, the air is induced into the furnace by the injector action of the burner itself, the air or steam used for atomizing purposes serving as the impelling force.

Oil atomizers and structures for controlling the air supply (air registers) are really but means to an end. They provide the means for securing rapid diffusion. And it is only by virtue of the property of diffusion that complete combustion can be effected without an excess of air.

As to the real nature of diffusion, it is known that at ordinary temperatures the particles of oxygen in the air are moving about in every conceivable direction at velocities averaging over 1,600 feet per second.

Any one molecule, however, moves only an inappreciable distance before being arrested by collision with another molecule. It therefore takes an appreciable time for a particle of oxygen to travel even a short distance. It is this time element that constitutes the great stumbling block when the attempt is made to burn a large amount of fuel in a small space.

The reason why intense combustion is easily attained with a charcoal fire is that the fuel is solid at the temperature of ignition. Being solid, it can present a large surface for the oxygen to act upon and an atom can not break away and go up the chimney without first being united with at least one atom of oxygen.

In the combustion of hydro-carbons, on the other hand, we have the following conditions: The fuel is already on its way to the chimney before it is even partially burned. The first effect of the heat is to dissociate the carbon from the hydrogen. Whether or not the latter unites with the oxygen does not affect the soot or smoke question, since the constituents and also the products of combustion of hydrogen are alike transparent gases. But in any case the carbon, left in the form of an impalpable dust, is much less favorably circumstanced than that in a charcoal fire. If it were attached to a hot coal, so as to be capable of receiving a blast of air, its combustion would be easily accomplished. But instead of this it is carried along by the current of gases, and unless it is given plenty of time before being cooled, it will be left alone as a particle of soot.

An examination of the nature of flaming leads to similar conclusions. The luminous part of a flame is caused by the white-hot particles of carbon. These particles have been robbed of the hydrogen with which they were formerly associated, and they have not yet met the oxygen necessary for complete combustion. The process of finding, or of being found by the oxygen requires time, and if perchance the temperature falls below that of ignition before the process is completed, the carbon will be deposited as soot or else go up the stack as smoke along with the excess of oxygen with which it should have been united. Thus an unmistakable symbol of the conditions that are necessary in order to burn a large amount of combustible in a small space is a short flame.

THE MECHANICAL ATOMIZING OIL BURNER.

It is only through mechanical atomization that a practically instantaneous diffusion of oil spray and air can be accomplished and, for this reason, the mechanical atomizing fuel oil burner seems destined to displace all other types.

In order to show just what takes place in a mechanical atomizer, reference is made to Fig 1, which is very similar to the United States Navy standard design. The same kind of spray may be produced by means of the somewhat simpler structure shown in Fig. 2, where the oil is forced through the grooves of a spiral, which fills the oil passage at a point immediately adjacent to the oil discharge orifice.

Oil under high pressure is delivered through the central passage in the atomizer and the transverse holes A, into the space B, which supplies four high-velocity jets through the slots C. These jets enter the space D tangentially and create a whirling current which is discharged through the orifice E. The centrifugal action of the whirling oil is reacted upon by the centripetal force exerted by the bounding surface of the orifice but the instant a particle of the oil is released from the orifice, it is no longer compelled by any force to travel in any direction other than in a straight line, which must be, in velocity and direction, the resultant of the two motions which it had while within the orifice E. * In the structure shown, every particle of oil, upon discharge, theoretically should travel forward at an angle of 30 degrees to the axis of the nozzle for the size of passages noted, so that the resulting spray would be distributed as over the surface of a cone.

Since virtually the same velocity is imparted to every particle of oil, while passing through the slots C, the nearer one approaches to the axis of rotation, the greater the number of revolutions it must make per second. The whirling stream of oil must therefore be hollow and, since the particles on the inner surface of the annular stream, while passing through E, make several times as many revolutions per second as those on the outer surface thereof, its various concentric layers are subjected to shearing and other forces, which produce a violent action, causing a myriad of minute streams to be discharged from the atomizer at very appreciably different angles to the axis. These streams are so close together at first, that they present the appearance of a continuous film, which rapidly decreases in density as the distance between the widely-diverging components increases and finally each stream itself breaks up into minute spheres, which never reunite, but bounce against one another like rubber balls.

It is with this kind of spray that one has to deal, from all mechanical atomizers, in the now-recognized meaning of the term.

The pioneer in the art of burning oil with mechanical atomization, was Louis Schutte of Philadelphia, Pa., to whom letters patent No. 391,865 were issued on October 30, 1888.

In Schutte's burner, the mechanically atomized oil is enveloped by a whirling current of air, which is left free to expand around the outside of the oil spray. There is nothing in his structure to exert an impelling force upon the whirling air in a direction toward the oil spray. The particles of oil continue on their rectilinear paths into the furnace, more or less independent of the air supply. Diffusion therefore proceeds slowly; an elongated flame is produced and complete combustion of the oil can be accomplished only when there is present an excess of air. If used for firing boilers much above their rated capacity, the large flame comes in contact with water-cooled surfaces and a part of it has its temperature lowered below the ignition point, so that smoke follows.

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* "Every body persists in its state of rest or of uniform motion in a straight line, unless it is compelled by some force to change that state."
Newton's First Law of Motion.

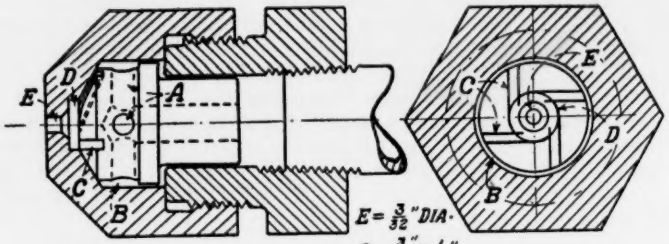


FIG. 1

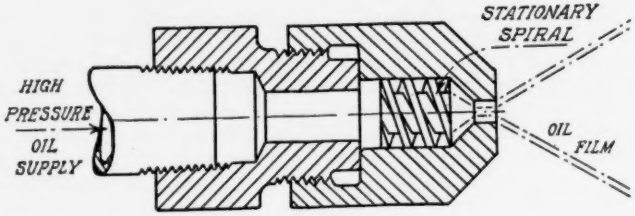


FIG. 2

U.S. PATENTS Nos 945,873 AND 1,066,161.

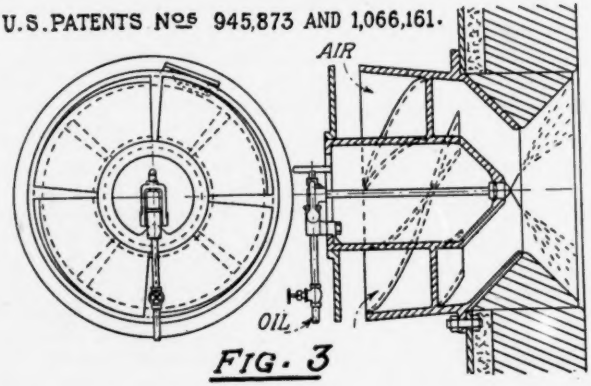


FIG. 3

THE STILZ OIL BURNER

On August 1, 1910, it was discovered that by directing a surrounding and whirling current of air more or less perpendicularly upon a cone-shaped film of oil, the air can be made to penetrate the oil film. By driving the whirling current of air in toward its axis of rotation (by means of a restricted discharge port or its mechanical equivalent) a miniature tornado is produced. ** A very violent action is therefore brought to bear upon the oil just as it is discharged from the atomizer. The resulting mixture of air and atomized oil spreads itself out in a cone-shaped current, which becomes ever more gentle as its distance from the apex increases.

By thus causing the oil film to whirl after it has been discharged from the atomizer, additional shearing stresses are created which assist in the atomization of the oil; and, what is vastly more important, the centrifugal action produces practically instantaneous diffusion of the two fluids. The fuel can be burned with short flame, no smoke and without excess of air.

The United States Government issued letters patent No. 1,066,161 under date of July 1, 1913, on this burner. Claim 1 of this patent reads:

"A nozzle having a small discharge orifice, means immediately adjacent to said orifice for producing a whirling motion in a liquid fluid passing therethrough, a casing surrounding said nozzle and having a restricted discharge port concentric with said orifice and means for causing a gaseous fluid passing through the space within said casing to enter said port in a whirling current."

It specifically covers structures similar to that shown in Fig. 3, where the air for combustion may be drawn through the burner by chimney draft, in a surrounding and whirling current and directed so as to penetrate the oil film, which, being thereby converted into a whirling cone of fuel, crosses the path of and commingles with the entire mass of the air, the centrifugal action offsetting the tendency of the air current to blow the oil spray toward the axis of the burner.

Claim 7 of patent No. 1,066,161 reads:

"In combination, a furnace having an admission hole through its casing, a lining of refractory material for said hole, a nozzle having means for projecting a hollow cone-shaped film of oil into said furnace through said hole,

---

** The terrific power of a tornado is due to the fact that winds from all quarters are driven in toward the axis around which they are whirling, with accelerated rate of the girations. The energy of the huge mass of rapidly moving air, covering a very large area, therefore, becomes ever more concentrated, the nearer the currents approach their common axis of rotation.

A tornado will throw the sea in violent agitation, elevate its surface around the axis of giration, tear it apart and carry the atomized spray up to the clouds, where the refrigerating effect thereof will cause a violent precipitation, which manifests itself in a water-spout. On land, the tornado has caused the walls and roofs of closed buildings to be thrown violently outward, as though an explosion had taken place from within. Buildings have been lifted entire from their foundations and carried several rods before being dashed to pieces; while large oak trees, nearly 7 feet in girth, have been snapped across like reeds.

In clean, concentrated violence, no other storm matches the tornado.

means surrounding said nozzle for producing a whirling stream of gaseous fluid directed so as to penetrate said film of oil, and means for supplying air into the furnace through said hole."

It refers more specifically to the structure which is illustrated in Fig. 5, where a relatively small volume of surrounding and whirling gaseous fluid (steam) is directed so as to penetrate the cone-shaped film of oil, thereby converting it into a whirling cone of fuel which, by centrifugal action, is projected over the entire area of the admission hole to

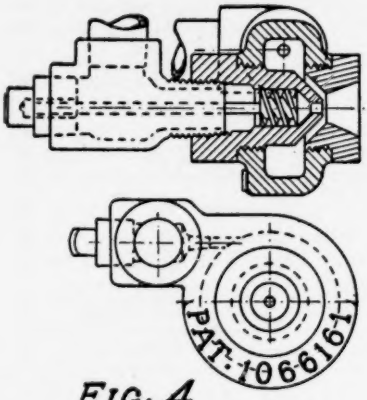


FIG. 4

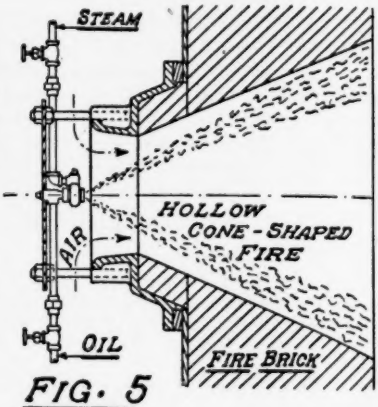


FIG. 5

the furnace and through the air which is supplied for its combustion, in precisely the same way as takes place within the restricted discharge port, which is specified in claim 1 and shown in Fig. 3.

By the doctrine of mechanical equivalents, however, each of at least four of the claims, which have been allowed in patent No. 1,066,161, cover all structures at present known by means of which a whirling spray of atomized oil can be produced under such conditions as are encountered in practice. It is the only known method for producing a whirling cone of fuel, which, by centrifugal action, will cross the path of and commingle with the air which is supplied for its combustion.

The burner, which is described in patent No. 391,865, causes two concentric streams to enter the furnace, the outer of which is composed of air and the inner one of oil spray. A burner, covered by patent No. 1,066,161, produces one ring-shaped current, composed of an intimate admixture of air and oil spray, prior to its discharge into the furnace. With the former, diffusion proceeds slowly, the mixing chamber extending throughout the entire furnace volume; with the latter, the diffusion is practically instantaneous, the mixing chamber being wholly within the burner structure, a thing apart from the furnace proper, the restricted area through the discharge port into the furnace being the place of demarcation.

PRACTICAL APPLICATIONS.

Furnaces.

With the instantaneous diffusion of finely-divided fuel throughout the entire mass of air which enters the furnace, the operator has under his absolute control the precise nature of the fire which is being produced. By admitting less air than is necessary to completely burn the fuel, the oxygen of the air quickly unites with the hydrogen component of the fuel, while the carbon component may be oxidized to carbon monoxide only, in which case the entire contents of the furnace may be filled with combustion gases, which are actively reducing in character. If more air is admitted to the furnace than is required for the combustion of the fuel, the contents of the furnace will be subjected to gases which, because of their high temperature in the presence of free oxygen, are actively oxidizing in character. The maximum temperature, of course, is produced when the combustion gases are neutral. These properties are of great importance to metallurgists and all those who are concerned with the melting, converting and heat-treating of metals.

Things can be done with the Stilz oil burner, which have to be seen in order to be believed. This burner can be pointed straight toward that which is being heated and no scale will be formed on a metal, as long as it is under the protecting cover of its fire, which takes the form of a hollow cone, the outer surface of which may be made to spread out at any angle up to 90 degrees to its axis.

This burner will eventually cause a greatly extended use of open-hearth furnaces for melting metals.

The number of heats which can be gotten out of a graphite crucible, under the action of a fire from this burner, is decidedly greater than can be obtained from any other known method of firing.

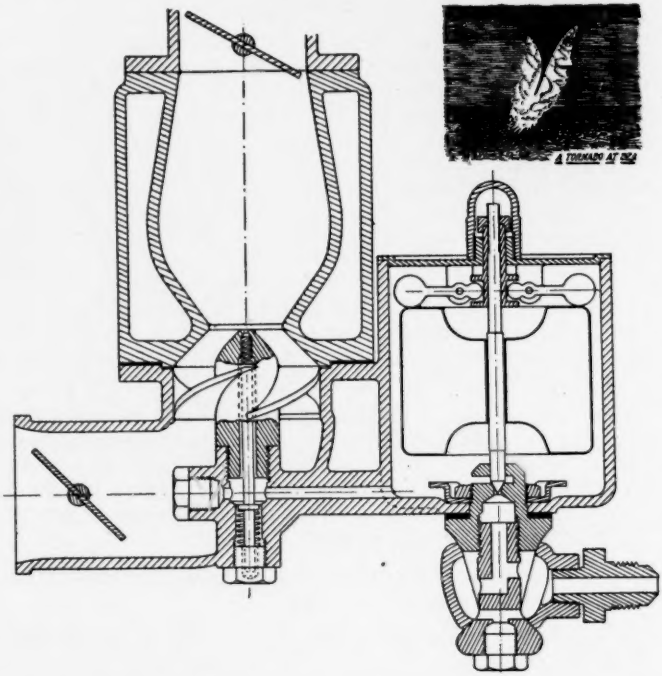
In firing boilers, it uniformly heats the furnace walls to incandescence, so that a large part of the heat is transmitted to the water by radiation. There is much less danger of boiler tubes blowing, since the flame from this burner does not impinge upon water-heating surfaces and free oxygen has been eliminated from the gases which do come in contact therewith.

A simple, cheap and efficient domestic heating equipment, embodying ths burner, should soon be ready for the market.

Gas Producers.

With means available for securing instantaneous diffusion, it will be possible to construct producers within which gas can be manufactured from powdered bituminous coal, at so low a cost that gas will ultimately displace coal for domestic heating and many other purposes. The advantages of this will be appreciated by all who have attended ordinary coal fires, or who have witnessed the hauling of coal and ashes through the streets of large cities.

THE "TORNADO" CARBURETOR



The carburetor is a most vital element in the mechanism of a gasoline engine. Although simple and cheap in itself, it extracts an appalling toll from all who use it in its present form, as is clearly indicated by the pungent odor of carbon monoxide in the wake of all automobiles. A pound of carbon, when burned to carbon dioxide, generates 14,650 heat units; when burned to carbon monoxide, it generates but 4,400 heat units.

It is the function of the carburetor to meter the most economical air-fuel mixture, at all loads and speeds of the engine; to uniformly distribute the fuel throughout the air, which is drawn into its several cylinders, and to cause a complete vaporization of the fuel before the mixture is ignited. The end in view is attained, when all of the fuel in the charge is completely burned within the engine cylinder, and when all of the oxygen in the charge can be made to enter into the combustion. The first makes for highest possible thermal efficiency at all loads, and the second for maximum power with a minimum engine weight.

The carburetor, which is illustrated above, embodies the same basic principle as has already been described. The air and gasoline are

both made to whirl through their respective restricted discharge orifices, centrifugal action producing practically instantaneous diffusion. The heavier constituents of the gasoline, which may not have been immediately vaporized, will be carried to the outer edge of the whirling current, where they will come in contact with the walls of the chamber, as shown with a jacket, so that exhaust gases from the engine may transmit heat thereto, in such quantities as will just vaporize all of the gasoline.

The speed of the engine is controlled in the usual way. The gasoline discharge orifice is made just large enough to supply the desired mixture, when operating at full load. A lean mixture is desirable at light loads. If there should be a tendency for it to become too lean, it can be rectified by causing a corresponding partial throttling through the air-intake butterfly valve, thereby causing increased suction on the gasoline nozzle.

Here one finds accurate metering, instantaneous diffusion and complete evaporation of the fuel, combined with simplicity in design and operation, in a device which bears about the same relation to other carburetors that the Stilz oil burner bears to the oil burner with which it competed in the test referred to in the Link-Belt letter shown on page 2.

A simple structure embodying this principle, for injecting fuel into a separately compressed charge of air, may revolutionize the construction of internal combustion engines, so that power may be produced at but a small fraction of its present cost. Developments along this line are already well under way.

COMPARATIVE MERITS.

Gas is the ideal fuel. The apparatus necessary to burn it is simple, cheap and efficient. The fuel is easily supplied to the consumer through underground pipes, from a reliably constant source of supply. A gas fire is very concentrated and may be readily controlled by simple automatic means, to meet the immediate needs of service. Gas can be burned anywhere with safety and, when the products of combustion are carried up a chimney, it leaves behind it nothing but heat. The use of gas is limited, however, to heating equipments which remain fixed, owing to the large space which is required to store the fuel required to develop a relatively small amount of heat.

Oil is the best fuel for use on board ships, locomotives, etc. It is easily stored. The labor in supplying it to the burners is reduced to a minimum. It occupies 34% less space and has 34% less weight than coal for an equal heat delivery. It eliminates the formation of soot, smoke, dust and ashes. Oil firing is flexible and the varying fluctuations of load can be followed instantly.

While the evaporative efficiency of a boiler, at is rated capacity, when fired with ordinary coal, is seldom above 70%, the same boiler when fired with oil, can be made to operate at three times its rated capacity and yield, at that overload, an evaporative efficiency of over 80%.

The only scientific way to burn coal is to grind it into an impalpable powder and then supply this pulverized coal through a burner where it can be intimately mixed with the air which is supplied for its combustion. In this way, boiler efficiencies and capacities on a parity with oil firing can be obtained.

When burned with the same degree of efficiency, one ton (2240 lbs. @ 13000 B. T. U.) of coal will produce about the same amount of heat as 200 gall. of oil, or 52,000 cu. ft. of manufactured gas, or 29,000 cu. ft. of natural gas.

The relative prices at which these fuels must be purchased in order to produce the same amount of heat per dollar expended are therefore about as follows:

Oil per gallon	Coal per ton	Manufactured Gas per 1000 cu. ft.	Natural Gas per 1000 cu. ft.
4 cents	$8.00	15.4 cents	27.5 cents
6 cents	12.00	23.0 cents	41.5 cents
10 cents	20.00	38.5 cents	69.0 cents

SERVICABLE DATA

The evaporation of 34.5 lbs. of water per hour from and at 212° Fahr. has been arbitrarily fixed as a boiler horse power. Water tube boilers are usually rated by allowing 10 sq. ft. of heating surface per boiler horse power. With improved combustion methods, however, it is possible to secure a good evaporative efficiency with less than 2½ sq. ft. of heating surface per boiler horse power developed.

A pound of fuel oil will produce as much heat as is required to evaporate 20 pounds of water from and at 212 deg. Fahr. The best evaporative efficiency, as reported to date from reliable sources, in oil fired boilers, is 84%.

Under ideal conditions fuels may be burned as follows:

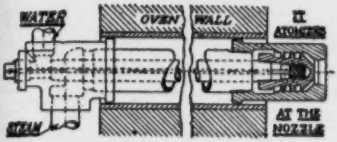
Kind of fuel	Air required	CO_2	B. T. U.
Carbon	11.3 lbs.	21.3%	14,650 per lb.
*Fuel Oil	13.3 lbs.	16.4%	19,440 per lb.
**Natural Gas	8.85 volumes	11.95%	1,000 per cu. ft.
Marsh Gas (CH_4)	16.9 lbs. or 9.4 volumes	11.9%	23,513 per lb. or 1050 per cu. ft.
Hydrogen (H_2)	33.9 lbs. or 2.35 volumes	none	62,100 per lb. or 347 per cu. ft.
†M'f'd. Gas	4.46 volumes	15.0%	558 per cu. ft.

(In the above, gases are measured at 32° Fahr. and atmospheric press.)

* Composed of 85.45% Carbon, 11.17% Hydrogen, 0.17% Sulphur, 0.23% Nitrogen and 2.98% Oxygen. 27.1 deg. Baume. Specific Gravity 0.892.

** Composed of 1.94% hydrogen, 93.85% Marsh Gas, 0.2% Olefiant Gas, 0.44% Carbon Monoxide, 0.23% Carbon Dioxide, 0.35% Oxygen, 2.98%, Nitrogen and 0.21% Hydrogen Sulphide. From St. Mary's, Ohio.

† From Philadelphia Gas Works; composed of 5.70% Carbon Dioxide, 7.45% Illuminants, 1.11% Oxygen, 20.06% Carbon Monoxide, 37.47% Hydrogen, 22.45% Marsh Gas and 5.76% Nitrogen.



Any kind of a liquid converted into a

PERFECT FOG

by highly efficient mechanical action.

For steaming bakers ovens, manufacturing powdered milk, carbonating water and many other operations where it is desirable to cause an extremely rapid action within a liquid through an exposure of a greatly expanded surface, this atomizer has no equal.

CONCLUSION.

The day seems close at hand when the now-prevailing crude and wasteful methods of burning fuels will not be tolerated.

Gas should be utilized chiefly in heating processes which are conducted on a small scale.

Oil is usually preferable where the relatively high first cost of the equipment, which is necessary to burn it economically, is more than offset by the lower cost of the fuel per heat unit developed.

Powdered coal is usually the best fuel to burn in all operations where there are very heavy demands for heat. With the aid of suitable burners, pulverized coal can be burned just like a gas. The heavy first cost of the pulverizing machinery and other equipment necessary to prepare and utilize powdered coal will soon be paid for through the greatly reduced operating expenses.

But the ideal way to distribute energy for heat, light and power is by means of electricity, and improvements in the internal combustion engine, which are even now over-due, will enable electricity to be generated at a very low cost.

The world is on the threshold of a new and wonderful era. A new culture shall be born. Other cultures have existed and passed away, because they entailed human slavery. The new culture shall endure and become universal, because huge mechanical slaves, with inexhaustible and illimitable energy, will unceasingly toil in the service of man. And this shall have been rendered possible because of the discoveries which have been made in means for producing cheap mechanical power.

MEANWHILE

Don't be misled by those who claim that combustion efficiencies depend upon furnace construction, for

It's All in the Burner!